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中国东北晚白垩世酢酱草属(酢酱草科)一新种：嘉荫酢酱草*

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Oxalis jiayinensis, a new species of the Late Cretaceous from Heilongjiang, NE China

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Abstract *Oxalis jiayinensis*, sp. nov., is described from the Late Cretaceous (Turonian-Senonian) in Jiayin County, Heilongjiang Province, northeastern China. The seed is about 1 mm long, less than 1 mm in diameter, crescentic with obtuse apices and 9～10 transverse ribs. The seed wall is composed of equiaxial, strongly thickened sclereids. The fossil represents the oldest occurrence of the family Oxalidaceae in the world.

Key words *Oxalis*; Seed; Late Cretaceous; Heilongjiang

The family Oxalidaceae has a world-wide distribution and is known from both living and fossil species. It has 7 genera including *Averrhoa*, *Biophytum*, *Dapania*, *Eichleria*, *Hypseocharis*, *Oxalis* and *Sarcotheca*. With the exception of *Eichleria* that is endemic to South America, species of the other six genera can be found in Eurasia although they mainly occur in South America and South Africa. The genus *Oxalis* includes more than 800 species with only ten of them being native to Eurasia, namely *O. acetosella*, *O. crenuae*, *O. corniculata*, *O. griffithii*, *O. hupehensis*, *O. leucolepis*, *O. martiana*, *O. obtriangulata*, *O. stricta*, and *O. violacea* (Engler, 1930). Species of this genus occurring in Europe have been revised into four species: *O. acetosella*, *O. corniculata*, *O. griffithii and O. stricta* (Anderberg, 1994). Species occurring in Asia have been combined into two species: *O. acetosella* and *O. corniculata*. *O. acetosella*, *O. griffithii* (*O. hupehensis*), *O. japonica* (*O. obtriangulata*) and *O. leucolepis* are reduced to subspecies of *O. acetosella*. *O. corniculata* and *O. stricta* are reduced to subspecies of *O. corniculata*. *O. martiana*

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is native to South America other than Asia (Huang *et al*., 1998). The organ genus *Oxalidites* was established by Caspary(1886) to describe fossil fruits that were pentamerous, oblong berry, including all the fossil fruits belonging to Oxalidaceae. The earliest records of the genus and the family were *O. brachysepalus* Casp. and *O. averrvhoides* Conw. from the Tertiary of Germany(Conwentz, 1886). Subsequently no additional fossils were reported until 1965 when seeds of *Oxalis acetosella* were found in the Quaternary of the former USSR (Katz *et al*., 1965). The fossil described here was found in the Late Cretaceous aged deposits of northeastern China and is assigned to a new species of *Oxalis* because it closely resembles living species of the genus. It is the oldest known representative of the family Oxalidaceae.

1 Material and Method

The fossil seed described here was extracted from samples collected from the Yongancun Formation, Jiayin County, Heilongjiang Province (48°52′30″N, 130°30′01″E). The Yongancun Formation is included in the Jiayin Group aged in the Late Cretaceous (Turonian to Senonian). The macroflora of the group was dominated by angiosperm foliage assigned to the genus *Trochodendroides*, and included several other angiosperm and gymnosperm leaf types in addition to fern foliage (Zhang, 1983).

The bulk sediment disaggregation and sieving techniques (Crane *et al*., 1996) were used to obtain charcoalified material. The specimen was examined under scanning electron microscope (Hitachi S800 and Philips SEM505).

Living material was obtained for comparative purposes from the Seed Herbarium, Institute of Botany, the Chinese Academy of Sciences. Seeds of *Oxalis corniculata* were boiled in 10% sodium hydroxide, neutralized in 5% hydrochloric acid, and brushed with a soft brush to remove the testal cap (Andersberg, 1994) to make them comparable to the fossil seed. Photographs were taken under SEM.

2 Systematics

Family: Oxalidaceae

Genus: *Oxalis*

Species: *Oxalis jiayinensis* Feng, Liu, Song et Ma, sp. nov. (Plate Ⅰ: 1~7)

Diagnosis: Seed flat, crescentic in outline with obtuse apex and base. Edges unequal. Testa transversely ribbed with 9~10 ribs, ribs often broken and conspicuous on the lateral margins of the seed. Seed wall composed of equiaxial, strongly thickened sclereids.

Dimension of seed: 1.13 mm long, 0.73 mm wide, and 0.51 mm thick.

Holotype: CBP9400

Repository: the National Museum of Plant History of China, Institute of Botany, the Chinese Academy of Sciences, Beijing.

Derivation of specific epithet: From the Jiayin County, the type locality.

Stratigraphic Horizon: Yongancun Formation.

Age: Late Cretaceous (Turonian to Senonian).

Type locality: Near Yongancun Village, Jianyin County, Heilongjiang Province, China (48°52′30″N, 130°30′01″E).

Description: SHAPE crescentic, laterally flattened. Apex and base obtuse. SURFACE transversely ribbed; ribs 9~10, and often broken and conspicuous on the lateral margins of the seed; ribs 0.03~0.04 mm high, 0.02~0.03 mm wide, 0.05~0.11 mm apart. Hilum inconspicuous. Chalazal area undifferentiated. Raphe absent. TRANSVERSE SECTION ovate. Edges unequal, one side acute and the other side truncate-emarginate. Seed wall about 0.05 mm thick, unspecialized and composed of equiaxial, strongly thickened sclereids. Embryo straight. SIZE approximately 1.13 mm long, 0.73 mm wide, 0.51 mm thick.

3 Discussion

The current fossil is characterized by the flat and crescentic shape, the transversely ribbed testa, the unequal edges and the strongly thickened sclereids. It shows no similarities with fossil species of *Oxalidites* that are of oblong fruits with well-preserved sepals and style (Table 1). The fossil seed is also different from that of *Oxalis actosella* in shape and dimension, particularly the details of seed surface with the former being transversely ribbed and the latter longitudinally ribbed (Table 1).

Table 1 The similarities between the current fossil and other fossil species of Oxalidaceae

Characters of current fossil	*Oxalis acetosella*	*Oxalidites averrhoides*	*Oxalidites brachysepalus*
ovate in transverse section with unequal edges	–	–	–
elliptic in longitudinal section	–	–	+
less than 1 cubic millimetre	–	–	–
transversely ribbed	–	–	–
seed wall composed of sclereids	?	–	–
embryo straight	+	–	–

+: similar; –: different; ?: unclear

Few details of the genus *Eichleria* are known, which presents problems for comparing it with the other members of the family Oxalidaceae. We therefore consider it possible to omit this genus from our discussion as a direct consequence of this and other factors mentioned in the context. Comparison among the current fossil and the other six genera demonstrates its taxonomic position (Table 2).

Table 2 The similarities between the fossil and extant genera of Oxalidaceae

Character of current fossil	*Averrhoa*	*Biophytum*	*Dapania*	*Hypseocharis*[1]	*Oxalis*	Sarcotheca[2]
ovate in transverse section	–	–	–	–	+	–
elliptic in longitudinal section	+	–	–	–	–	+
less than 1 cubic millimetre	–	+	–	–	+	–
transversely ribbed	–	–	–	–	+	–
embryo straight	+	+	+	–	+	+

+: similar; –: different; 1: cited from Boesewinkel(1988); 2: cited from Lack(1987)

The current fossil seed has more common features with seeds of *Oxalis* than with those belonging to the other genera and these similarities make it possible to assign our fossil to the genus *Oxalis*. In table 3 we compare the fossil with the extant species of the genus native to China to allow a precise identification of the species.

Table 3 Comparison between fossil and extant native species of *Oxalis* of China

Taxon	Shape	Length(mm)	Ribs	Apex	Base	Rib Width(mm)
O. acetosella	elliptic	2.0～3.0	longitudinal	obtuse	acute	≥0.10
O. corniculata	elliptic	1.1～1.9	transverse	obtuse	acute	0.05～0.10
O. jiayinensis	crescentic	1.1	transverse	obtuse	obtuse	≤0.03

The fossil has distinct characters that make it differ from all living species of the genus in China, namely a crescentic shape, an obtuse base and 9～10 transverse narrow ribs. All of these comparisons suggest that this fossil is a new species of *Oxalis*. The key to our fossil and the extant native species of China is as follows:

Key to species

1. Seed 2.0～3.0 mm long, longitudinally ribbed ······································ 1. **O. acetosella**
1. Seed 1.1～1.9 mm long, transversely ribbed.
  2. elliptic, base acute, ribs 0.05～0.10 mm wide ···································· 2. **O. corniculata**
  2. crescentic, base obtuse, ribs less than 0.03 mm wide ································ 3. **O. jiayinensis**

Oxalis jiayinensis is the earliest known representative of the family Oxalidaceae. It has several features that we interpret to be primitive within the family including its asymmetrical shape, poorly developed ribs and unspecialized seed wall. These features suggest that the genus of *Oxalis* may have originated from a genus or family in which the seeds possessed a smooth surface and unspecialized seed wall. This also demonstrates two important tendencies of seed wall specialization and rib development in seed evolution of the genus. The discovery of the fossil suggests that the Oxalidaceae had evolved by the Late Cretaceous, considerably extending the previously known geological range of the family. The paper is also the first report of charcoalified seeds of the Late Cretaceous age in China, which is anticipated to stimulate research in this field within China.

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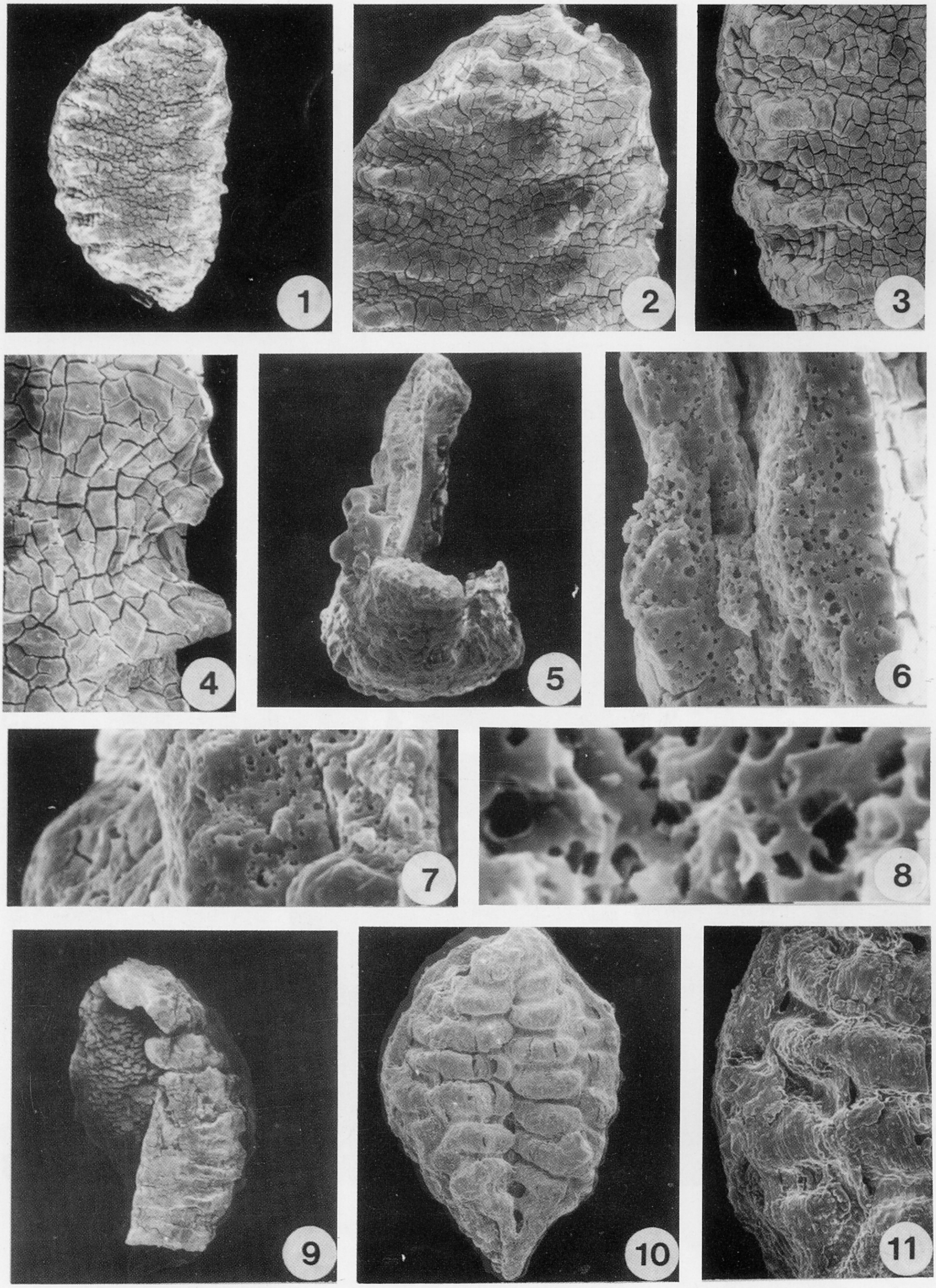
Explanation of the Plate

Plate Ⅰ 1. Holotype, seed showing transversely ribbed testa (CBP9400, SEM×25); 2. Enlargement of fig. 1, showing undifferentiated chalazal area (SEM×46); 3. Surface of holotype enlarged to show ribs at the curve side(SEM×60); 4. Detail of holotype showing ribs at the straight side (SEM×126); 5. Cross section of holotype showing the unequal edges (SEM×125); 6. Detail of seed wall in longitudinal section showing strongly thickened sclereids (SEM×277); 7. Enlargement of fig. 5 to show sclereids (SEM×600); 8. Detail of fig. 7 (SEM×2450); 9. Counterpart of holotype (SEM×25); 10. Extant *Oxalis corniculata* L. (SEM×25); 11. Enlargement of fig. 10, showing ribs (SEM×60).

摘要 本文描述了发现于中国黑龙江省嘉荫县晚白垩世(土仑期至赛诺期)的酢酱草科酢酱草属新种 *Oxalis jiayinensis* Feng, Liu, Song et Ma; 炭化种子长约 1 mm,宽不足 1 mm;新月形,两端钝;表面具 9～10 条横脊;种皮石细胞等轴、细胞壁明显加厚。该化石种是酢酱草科在地质时期迄今最早的代表。

关键词 酢酱草属; 种子; 晚白垩世; 黑龙江

冯广平等：中国东北晚白垩世酢酱草属(酢酱草科)一新种：嘉荫酢酱草 图版Ⅰ
FENG Guang-Ping *et al*.: *Oxalis jiayinensis*, a new species of the Late Cretaceous from Heilongjiang, NE China Plate Ⅰ



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